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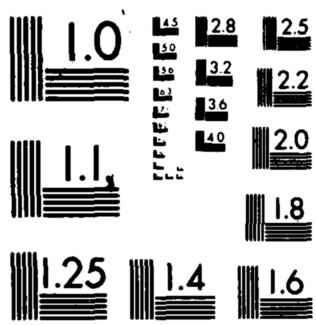

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TECHNOLOGY TRANSFER OF THE AIR QUALITY ASSESSMENT MODEL

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Air Quality Assessment Model (AQAM) is used by the Air Force to estimate and predict present and future local air pollution concentrations resulting from onbase activities. Every major air pollution source on an airbase is accounted for by AQAM.

AQAM originally [illegible] compatible with the computers of the Air Force Engineering [illegible]). Upon completion of AQAM prototype development, technology transfer to the USAF Occupational and Environmental Health Laboratory (USAF OEHL) for field application began.

This project involved making all necessary installations, tests, modifications and evaluations to make the model compatible with USAF OEHL computers.

This report describes the AQAM model and the required modifications for the USAF OEHL computers. New subroutines and changes to the original subroutines are documented. Information on data preparation, processing, and display is provided for the operator.

PREFACE

This final report was prepared by the Air Force Engineering and Services Center, Engineering and Services Laboratory, (AFESC/RDV) Tyndall AFB, FL. This report covers AFESC research performed by the Research Triangle Institute, Research Triangle Park, NC 27709, under Contract No. F-33615-80-D-4000 with the USAF Occupational and Environmental Health Laboratory, Brooks AFB, TX.

Work on this project was performed from December 1981 through July 1983. The project officers were Maj Edward Artiglia (USAF OEHL), Capt Dan Berlinrut (AFESC), and 2Lt Glenn Seitchek (AFESC). Lt Col Dennis Naugle (USAF OEHL), Dr. Joe Sickles (RTI), Ms. Liz Gordon (RTI), and Mr. Allan Tang (RTI) contributed significant ideas and efforts to make the research project successful.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for public release.

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SECTION I

INTRODUCTION

A. THE AIR QUALITY ASSESSMENT MODEL

The Air Quality Assessment Model (AQAM) computer program is used by the U.S. Air Force to estimate air pollution concentrations resulting from air installation activities. This complex air quality dispersion model considers every major air pollution source on an airbase. Four major components comprise AQAM: the edit program, the source inventory, the short-term dispersion program, and the plot program. The edit program detects errors in the AQAM input data and ensures input correctness before AQAM is executed. The source inventory identifies the location, emission rate, and pollutant type for every pollutant source. The short-term dispersion program calculates the resultant pollutant levels at various receptor points as a function of meteorological conditions. The plot program displays the output results of AQAM in a clear format.

The following documents are recommended for further information about AQAM:

1. AFWL-TR-74-279, USAF Aircraft Takeoff Length Distances and Climbout Profiles.
2. AFWL-TR-74-304, A Generalized Air Quality Assessment Model for Air Force Operations.
3. AFWL-TR-75-307, Air Quality Assessment Model Data Reduction and Operations Guide.
4. CEEDO-TR-76-33, Air Quality Assessment Model for Air Force Operations - Source Emissions Inventory Computer Code Documentation.
5. CEEDO-TR-76-34, Air Quality Assessment Model For Air Force Operations - Short-Term Emission/Dispersion Computer Code Documentation.

6. Draft Technical Report, Air Quality Assessment Model Data Collection Guide.

7. ESL-TR-81-60, Development of a Computer Emission Inventory Routine for Aircraft Ground Support Equipment, Volumes I and II.

B. TASK DESCRIPTION

The primary task of this project was to produce, install, test, evaluate, and modify computer software, yielding an operational AQAM on the computer facilities of the U.S. Air Force Occupational and Environmental Health Laboratory (USAF OEHL), Brooks AFB, TX. The secondary task was to enhance AQAM's basic capabilities by improving the data input process and adding data output features.

The first of the two goals of this task, the installation of AQAM at OEHL, involved the transfer of the four programs just described from a CDC host machine at AFESC to an IBM/HP host configuration at USAF OEHL. Specifically, the Edit Program and the Plot Program were targeted for the HP 1000 at OEHL; the Source Inventory Program and the Short-Term Emission/Dispersion Program were devised for the IBM 4341 at the San Antonio Data Services Center (SADSC). This particular assignment of programs to machines was necessitated primarily by the size of the two latter programs; with no virtual memory, the HP 1000 could accommodate neither the Source Inventory Program nor the Short-Term Program without considerable program restructuring. Hosting the input and output segments of AQAM on the HP 1000 offered the additional feature of placing the man/machine interface of AQAM under more direct user control.

The second task involved restructuring the AQAM input segment. A card input deck was replaced with a disk file, created with the general-purpose editor on the HP 1000. At the same time, the Edit Program was replaced with an interactive "Source Check Program" with expanded capabilities in checking the Source Input File for errors. Concurrently, runway roll was added to the set of default parameters describing the landing and takeoff profiles of aircraft. This resulted in elimination of explicit computation of runway roll in both the Source Inventory Program and the Short-Term Emission/Dispersion Program.

The second aspect in improving AQAM was to provide output options in addition to those indicated above, specifically the following:

1. An "Emission Inventory Listing," which would be a condensed, reordered, and more accessible version of the Source Inventory Listing;

2. "Emission Summary Graphs" to portray various annual emission levels in the form of bar graphs;

3. A "Source Map" showing the location of aircraft sources, as well as airbase point, area, and line sources, as overlays on an airbase map.

C. RESULTS

1. Software Configuration

The configuration for AQAM which evolved from this effort is shown in Figure 1. The dual-host nature of the OEHL computer configuration subdivides the AQAM package into three distinct segments:

a. Data Preparation Segment

b. Data Processing Segment

c. Data Display Segment

The first and last of these segments relate to the HP 1000 and are structurally identical with the input and output segments, respectively, of the original version of AQAM. The middle segment, relating to the IBM 4341 and now termed the data processing segment, differs considerably, however, from the original, at least from the perspective of a user. The original cascade arrangement, involving an intermediate file, is replaced by five single-purpose programs:

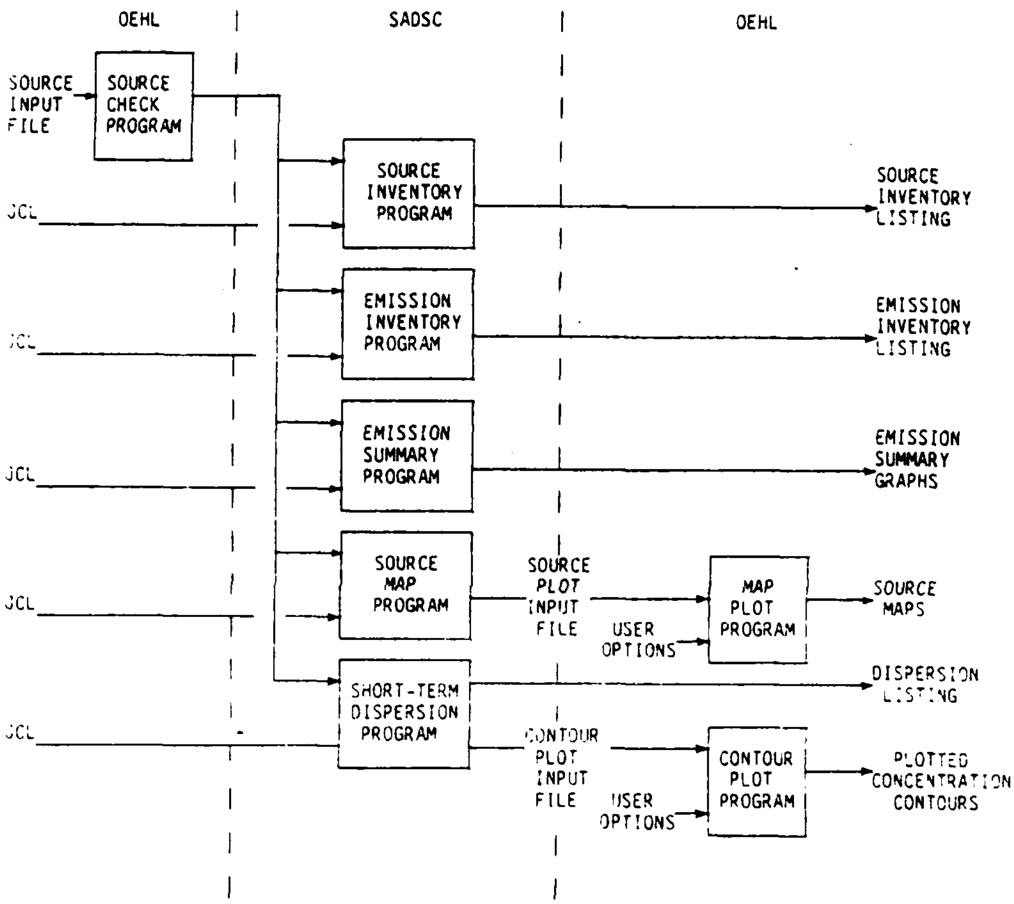

Figure 1. Revised AQAM Configuration

a. Source Inventory Program

b. Emission Inventory Program

c. Emission Summary Program

d. Source Map Program

e. Short-Term Dispersion Program

All operate on the same input file--the Source Input File--to produce their respective outputs. Eliminated in the process are all intermediate files except those required to communicate between the IBM 4341 at SADSC and the HP 1000 at OEHL.

To obtain a Source Inventory Listing, the user now runs the Source Inventory Program; to obtain a Short-Term Dispersion Listing and "Contour Plot Input File," he runs the Short-Term Dispersion Program. Since there are now two plot outputs, they are distinguished by the qualifiers "Map" and "Contour."

2. Runway Roll

In the original version of AQAM, runway roll--the distance a departing aircraft travels on the runway between the time of brake release and the time of liftoff--was computed on-line from more basic parameters: aircraft type, aircraft gross weight, pressure altitude, temperature, and wind velocity (Reference 1). This approach is recommended because it accurately characterizes the line source created by departing aircraft. Nevertheless, the computation has occasionally produced spurious results. For this reason, runway roll in the revised version of AQAM is treated as a primary parameter, descriptive of each type of aircraft in the model, becoming a part of the default data of the various programs where it is required. Although treating runway rolls in this manner entails a loss of modeling accuracy, the loss is not deemed significant. Moreover, the user is still able to override the default data with his own runway-roll values.

The default values assigned to the runway-roll parameter correspond to those produced by the original formulas under the following meteorological conditions:

a. Temperature = 60°F

b. Pressure Altitude = 3000 Feet

c. Wind Velocity = Headwind at 3 knots.

The results of this computation are shown in Table 1. As indicated in the figure, the computed and assigned runway roll values correspond. The exceptions are seen in the following cases:

a. Aircraft 13 (F-5) - computed value of 5790 feet and assigned value of 2600 feet.

b. Aircraft 19 (C-5A) - computed value of 9879 feet and assigned value of 4500 feet.

c. Aircraft 20 (C-9) - computed value of 8011 feet and assigned value of 6200 feet.

d. Aircraft 21 (C-130) - computed value of 8054 feet and assigned value of 1700 feet.

e. Aircratt 23 (C-135) - computed value of 6297 feet and assigned value of 5000 feet.

f. Aircraft 24 (C-141) - computed value of 6231 feet and assigned value of 2600 feet.

g. Aircraft 34 (T-41) - computed value of 1120 feet and assigned value of 700 feet.

h. Aircraft 44 (C-130H) - computed value of 8854 feet and assigned value of 1700 feet.

i. Aircraft 47 (F-16) - computed value of 3402 feet and assigned value of 2200 feet.

In all cases, the assigned values are consistent with those listed in Jane's All the World's Aircraft.

3. Problems Encountered

The problems encountered in the performance of the technology transfer are characteristic of this type of work. Despite claims made for the portability of FORTRAN, the fact remains that a FORTRAN program written for one machine is not readily transferable to another. Differences in the language itself, the use of the machine-specific constructions, and differences in word length conspire to make such a transfer difficult.

TABLE 1. RUNWAY ROLL DISTANCES

Aircraft ID	Aircraft Name	Take Off Weight (1000 lb)	Runway Roll Equation	Runway Roll Computed	Assigned Distance (Feet)
1	Unassign	0.0	100	0.	0.
2	B-52D/F	340.0	2	5998.	6000.
3	B-52H	340.0	3	5998.	6000.
4	B-57A-E	45.0	4	4331.	4300.
5	B-57F	45.0	5	4331.	4300.
6	F-100	36.0	6	7177.	7200.
7	F-101	45.0	7	3187.	3200.
8	F-102	30.0	8	2846.	2800.
9	F-104A	20.0	9	4386.	4400.
10	F-105	45.0	10	4257.	4300.
11	F-106	35.0	11	3961.	4000.
12	F-4C/F	50.0	12	3349.	3400.
13	F-5	18.0	13	5790.	2600.
14	F-111A	75.0	14	3189.	3200.
15	F-15	42.0	15	2215.	2200.
16	A-7	30.0	16	3478.	3500.
17	A-10	35.0	17	2356.	2400.
18	A-37	11.0	18	2299.	2300.
19	C-5A	712.0	19	9879.	4500.
20	C-9A	102.0	20	8011.	6200.
21	C-130	155.0	21	8854.	1700.
22	KC-135A	220.0	22	6297.	6300.
23	C-135B	220.0	23	6297.	5000.
24	C-141A	323.0	24	6231.	2600.
25	C-7	24.0	25	1420.	1400.
26	C-121	50.0	26	4481.	4500.
27	Unassign	0.0	100	0.	0.
28	Unassign	0.0	100	0.	0.
29	Unassign	0.0	100	0.	0.
30	T-33	14.0	30	3413.	3400.
31	T-37	6.0	31	1797.	1800.
32	T-38	12.0	32	2752.	2800.
33	T-39	14.0	33	2038.	2000.
34	T-41	4.5	34	1120.	700.
35	0-1	4.5	35	1120	1100.
36	0-2	4.5	36	1120.	1000.
37	OV-10	11.0	37	1039.	1000.
38	B-52G	340.0	2	5998.	6000.
39	F-104C	20.0	9	4386.	4400.
40	F-4E	50.0	12	3349.	3400.
41	F-111D/E	75.0	14	3189.	3200.
42	F-111F	75.0	14	3189.	3200.
43	C-5LS	520.0	19	4519.	4500.

Pressure Altitude (HFt): 30
Temperature (°F): 60
Wind Speed (Knots): 3

TABLE 1. RUNWAY ROLL DISTANCES (CONCLUDED)

Aircraft ID	Aircraft Name	Take Off Weight (1000 lb)	Runway Roll Equation	Runway Roll Computed	Assigned Distance (Feet)
44	C-130H	155.0	21	8854.	1700.
45	Unassign	0.0	100	0.	0.
46	Unassign	0.0	100	0.	0.
47	F-16	33.0	47	3402.	2200.
48	Unassign	0.0	100	0.	0.
49	Unassign	0.0	100	0.	0.
50	Transent	50.0	12	3349.	3400.

Pressure Altitude (HFt): 30
Temperature (°F): 60
Wind Speed (Knots): 3

A further complicating factor was the undocumented changes in the original AQAM code. The impact of these changes will require one to either learn the original program in its entirety, or to make an educated guess as to what was intended. Both cases would be extremely time-consuming.

Another important concern is the IBM 4341 machine at SADSC and its link to OEHL. Presently, this computer exhibits slow turnaround times (particularly during normal working hours), and is generally not used by personnel at OEHL (who, therefore, tend not to be knowledgeable in its use). The SADSC computer connects to the HP 1000 through an unreliable communications link. As long as SADSC hosts the computational segment of AQAM, there will likely be problems in its use. Unfortunately, the alternative of hosting all programs on the HP 1000 remains untenable, until the new RTE-6 operating system is installed on this machine.

A final problem, but one which will be corrected in the near future, is the lack of plotter resources on the HP 1000. Although a new HP 8-pen plotter is now available, the vendor-supplied software to support it is not. Until this software is installed, progress on the output segment of AQAM is halted.

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SECTION II

COMPUTER CONFIGURATION

The computer configuration shown in Figure 2, consists of two central processors: the HP 1000 minicomputer at OEHL and the IBM 4341 main frame at SADSC, linked by a remote job entry terminal. With respect to AQAM, the first processor serves as an input/output device and, the second, as a computational machine.

Peripherals interfaced to the IBM 4341, include numerous tape and disk drives. For ease of operation, the "working" AQAM files, which contain source code, compiled code, and supporting data files, should be stored on an on-line disk pack where they will always be available with no advance notice. Copies of these files should be stored on an off-line disk pack, so that if a system malfunction destroys the contents of the on-line disk pack, the off-line files can then be restored to the system.

The peripherals on the HP 1000 are of direct interest to the AQAM user, because they serve as his interface to the model. Figure 2 shows the CRT-terminal and printer in the "AQAM Terminal Room," together with the printer and plotter in the HP 1000 "Computer Room." The former peripherals are used in preparing AQAM input data and the latter for obtaining the AQAM output products. Also of interest are the tape and disk drives on the HP 1000. Again, it is recommended that all AQAM programs be kept both on this machine and backed up by magnetic tape. Source Input Files should also be backed up.

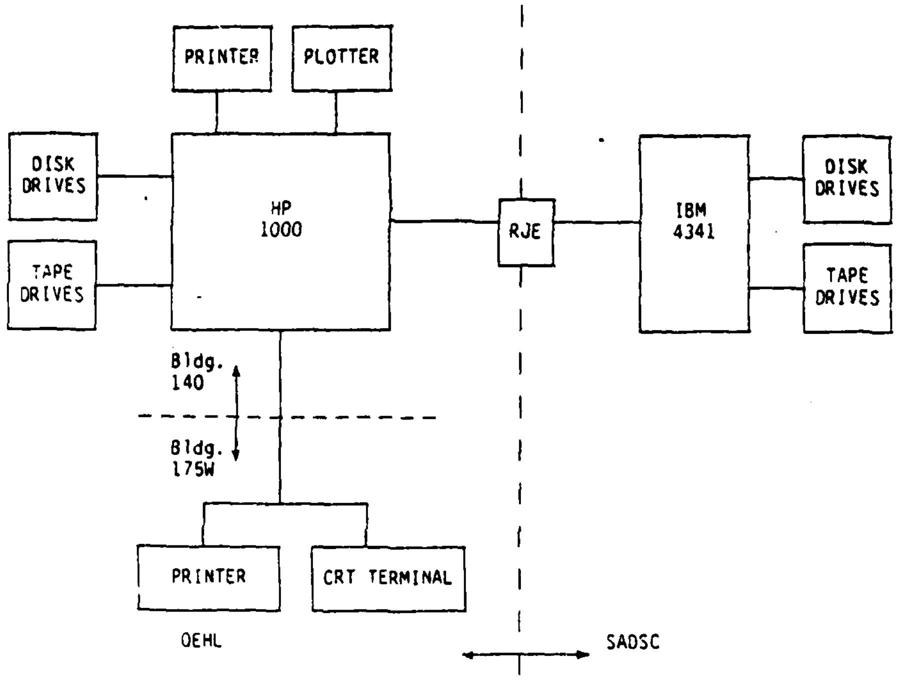

Figure 2. AQAM Computer Configuration

SECTION III

OPERATOR'S GUIDE TO AQAM

A. DATA PREPARATION

Data preparation refers to the creation of a Source Input File, which is described on pages 13 through 106 of AFWL-TR-75-307. Although this report is predicated on the use of punched cards and refers to input to the original Source Inventory Program, it, nevertheless, applies to the Source Inventory File in its current form. The Source Input File is now a disk-resident file, composed of card images.

In place of a key punch, the operator now employs the general-purpose editor on the HP 1000 to create the Source Input File. The original rules concerning structure and format of source data remain in force.

Having prepared a Source Input File, the operator employs the Source Check Program (AQEDT), instead of the old Edit Program, to check for errors in the file which could lead to difficulties in subsequent data processing activities. If errors are detected, the operator corrects the file and once again subjects it to AQEDT. The process is repeated until a logically correct file is created. At this point the file is ready for the next operation-data processing.

The Source Check Program expects the Source Input File to be stored in a disk file named:

@AQDAT:AQ:WK

where "@" is a prefix referring to a data file, "@AQDAT" is the name of the file, "AQ" is the security code, and "WK" is the disk unit on which the file resides.

Because of the labor involved in creating a Source Input File, it is recommended that a backup file to @AQDAT be maintained at all times. It is suggested that all editing and checking operations be performed on @AQDAT, but that this file be copied periodically into another file for safekeeping. This can be accomplished by typing a command of the form:

/EC,@name:AQ:WK

where "name" refers to the file in which the data are to be saved. For example, one could use the file name @HSTDC to refer to the "C" version of data from Homestead AFB. Here "HSTD" represents a four-letter airbase identifier and "C" could indicate the third in an historical series of data files prepared for Homestead AFB.

B. DATA PROCESSING

Data processing refers to those activities through which the Source Input File is converted into a Source Inventory, Emission Inventory, Emission Summary, Source Map, or Short-Term Dispersion Assessment. To perform any of these tasks, three steps are performed:

1. Convert the data file @AQDAT into a JCL file;
2. Adapt the appropriate JCL file to the job desired.
3. Run the job via the Remote Job Entry link to SADSC.

All of these steps occur on or with respect to the HP 1000; the fact that the job is being performed on the IBM 4341 at SADSC should be apparent to the operator.

To convert @AQDAT to the proper JCL file, named :

/AQDAT:AQ:WK

a few JCL statements are added both in front of and behind the source data contained in @AQDAT. Next, the operator adapts one of the following JCL files on the HP 1000 to the job desired.

1. Source Inventory: /SIPGM:AQ:WK
2. Emission Inventory: /EIPGM:AQ:WK
3. Emission Summary: /ESPGM:AQ:WK
4. Source Map: /SMPGM:AQ:WK
5. Short-Term Dispersion Assessment: /STPGM:AQ:WK

Only the last file needs to be modified from job to job. In this case, additional data must be user-supplied according to the directions for preparing short-term dispersion input data given on pages 107-138 of the AQAM Data Collection Guide. The additional data are inserted directly into the JCL file controlling the execution of a short-term dispersion analysis.

Both"/AQDAT and"/--PGM" files are submitted to SADSC to complete the data processing operation. This task is performed by personnel in the Automated Processing Division, Programming Branch, who will notify the operator when the job has been completed and is available for pickup.

C. DATA DISPLAY

Data Display refers to the operation from which a final output of AQAM is obtained. In the case of the Source Inventory, Emission Inventory, and Emission Summary output, this operation is simple. For a portion of the Short-Term Dispersion Assessment output and source listing, nothing needs to be done by the operator. For the Source Map output, the Map Plot Program is used. For the remainder of the dispersion assessment output, the Contour Plot Program is used. Further discussion of these display tools awaits final installation of the HP 8-pen plotter at OEHL.

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SECTION IV

SOFTWARE DOCUMENTATION

A. NEW SUBROUTINES

1. Data Preparation (AQEDT)

The only program constituting the data preparation phase of AQAM, in addition to the general purpose editor on the HP 1000, is AQEDT, the Source Check Program. This program consists of a main program, three segments overlaid on one another, and a variety of subroutines. It accepts as input the Source Input File, stored in a disk file named @AQDAT, and produces as output an annotated listing of the input file and any errors detected therein. The program is operated interactively from a terminal.

Checking a Source Input File is done by three distinct passes through the data. The first pass, performed by the segment PASS1, checks the overall structure of the data, determining whether all data sets (#1-#37) are present and in the proper order. The second pass (PASS2) checks the structure of each individual data set and ascertains whether the data sets are mutually consistent with one another. The final pass (PASS3) examines individual data fields for correctness. The prerequisite for performing any given pass is that no errors were detected in the preceding one. The task of checking a given data set in the second and third passes is allocated to a distinct subroutine, the name of which is of the form "CHKnn" in the second pass and "EDTnn" in the third pass, where "nn" denotes the data set number.

2. Data Processing

Five main programs comprise the computational segment of AQAM. The Source Inventory Program, the Emission Inventory Program, the Emission Summary Program, the Source Map Program, and the Short-Term Dispersion Program, are all hosted on the IBM 4341. These are not programs in the usual sense of the word. Rather, they are made to appear so by joining together a pair of more fundamental programs through JCL. The first element in each pair is a common, general-purpose, front-end processor; the second is one of four postprocessors chosen to create the desired output. This program linkage through JCL allows the underlying structure of the computational segment of AQAM to remain invisible to the user.

The subsections which follow describe each of these five basic programs, beginning with the front-end processor.

a. SRCINV: The front-end processing program referred to above is called SRCINV. In its present form, it does not produce a Source Inventory Listing, but functions solely as a preprocessor, much as the original version of the program functioned as a preprocessor for the dispersion programs. The purpose of SRCINV is to transform the Source Input File into four different output files, which, in the overall design, appear as intermediate files. The appropriate one of these files is then converted into the desired output by one of the four postprocessor programs (Figure 3). The advantage of this design for the processing segment of AQAM is that it maximizes the use of existing software and eliminates the necessity for user-handling of intermediate files. Its disadvantage is that it entails extra computation, i.e., rerunning SRCINV in its entirety when only a small portion of the program is of interest. The additional cost incurred is small, compared to the costs involved in maintaining an inventory of intermediate files.

Although much changed in scope from the original version of the program, the new SRCINV is, in fact, just a streamlined version of its predecessor.

b. SELIST: The postprocessing program responsible for producing both Source Inventory and Emission Inventory Listings is named SELIST. The input to this program, the first of the outputs of SRCINV, is similar to the Source Inventory Listing itself, but lacks all introductory material and all headings. SELIST rearranges this file and inserts the appropriate introductory material and headings to create the desired output listing.

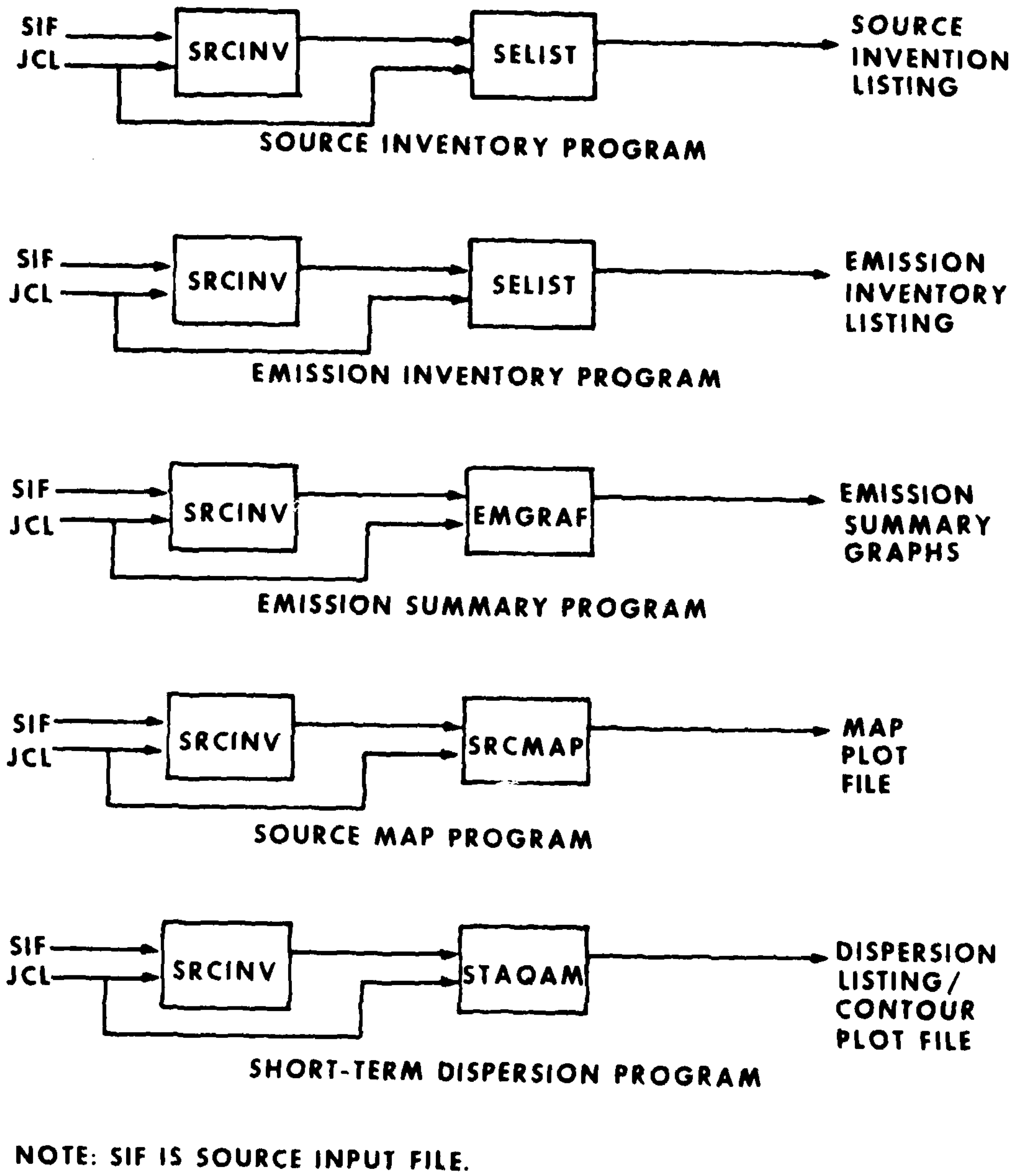

FIGURE 3. AQAM Data Processing Software Structure

c. EMGRAF: The program, EMGRAF, accepts the second of the output files produced by SRCINV and displays the data in the form of bar graphs depicting annual emission levels of various pollutants, categorized according to the type of source.

d. SRCMAP: The program, SRCMAP, accepts the third of the output files of SRCINV consisting primarily of source geometric data, and converts this data into plot files. These files will eventually be converted into color-coded displays indicating the locations of (1) aircraft line sources; (2) airbase point sources; (3) airbase area sources; and (4) airbase line sources.

e. STAQAM: The last, and most complicated, of the post-processing programs is STAQAM. This program is virtually identical to the original Short-Term Dispersion Program.

3. Data Display

The programs representing the data-display segment of AQAM are hosted on the HP 1000. They are: MAPPLT, to plot source maps, and CONPLT, which plots concentration contours. Each of these programs uses the HP 8-pen plotter to produce color plots.

a. MAPPLT: The purpose of MAPPLT is to transform the data provided by the source map program into color-coded plots indicating the location of emission sources.

b. CONPLT: The purpose of CONPLT is to contour the concentration data generated by the Short-Term Dispersion Program and plot the resulting contours.

B. AFESC AQAM CODE

1. Code Changes

Numerous undocumented changes had been performed on the original AQAM source coding. The coding was originally documented in April 1977 in CEEDO-TR-76-33 for the Source Inventory and in CEEDO-TR-76-34 for the Short-Term Dispersion Program. Between 1977 and 1981 the code underwent continuous review and development. In 1981, a copy of the code was sent from AFESC to OEHL to accomplish the technology transfer and yield AQAM operational for Air Force wide use. Between 1981 and 1982, modifications were performed on this version of AQAM to make the code compatible with OEHL computer hardware. Changes were also made to make interpretation of output information easier.

This section is intended to document the current AQAM computer code as it exists on the AFESC computer system. In the Source Inventory, Program SRCINV replaced Program MAIN and Subroutine FIRST. Program SRCINV, the main program of the Source Inventory, calls subroutines, writes the output tape, and prints the annual emission summary. Subroutine CONVRT, a new subroutine, reads the string of characters input to the namelist data set. This function was originally performed within Program MAIN.

In the Short-Term Dispersion Program, Function ERF was added to increase accuracy of the output by using a mathematical approximation function to compensate for IBM computer digital truncation. Program AQAMST replaced Program MAIN. Program AQAMST is the main driver routine, reading receptor and other general data and controlling all subroutines. Program OUTPUP replaced Subroutine OUTPUT to print the pollutant concentrations at all receptors resulting from environ, airbase, aircraft, and total combined sources. Program INTRO produces introductory information at the beginning of the Short-Term Dispersion Program output. This function was originally performed within Program MAIN. Subroutine LETTER produces the banner title at the front of the output and Subroutine CHARAC provides data to Subroutine LETTER. The functions of these two subroutines were originally carried out within Program MAIN.

2. Code Documentation

Complete Source Code Listings of the Current AFESC Source Inventory Program, and the Short-Term Dispersion Program are stored at the Air Force Engineering and Services Center.

C. OEHL AQAM CODE

1. Code Changes

This section is intended to document the current AQAM computer code as it exists on the OEHL computer system. Changes were made to eliminate as much machine-specific coding as possible and to make AQAM fully functional on the OEHL computer. A set of emission inventory subroutines for aircraft ground support equipment (GSE) was incorporated into the Source Inventory Program. Nonessential or insignificant subroutines were removed or modified to minimize computer core requirements. A new edit routine became necessary to check input data for OEHL computer machine-specific requirements. New subroutines were added to make the output easier to read, understand, and apply.

In the Source Inventory Program, Subroutine ABEMIV replaced subroutines CHARAC and LETTER to process airbase emission source inventory output. Subroutine ADLNIV replaced Function RRDIST to define line-source geometry for arrivals and departures of aircraft in given wind conditions. Subroutine AIRFLD was added to accept airfield data. The GSE emissions inventory capability consists of Subroutines GRDSRV, GROUND, and GSEFCT. Subroutine GRDSRV accepts aircraft ground support equipment data. Subroutine GROUND computes annual emissions from ground support equipment operations. Subroutine GSEFCT computes ground support equipment emission factors. Further information on the GSE subroutines' functions and operations may be found in ESL-TR-81-60, "Development of a Computer Emission Inventory Routine for Aircraft Ground Support Equipment," Volumes I and II.

The Source Inventory Program also contains a set of subroutines to print a summary of each type of emission. Subroutine METSUM prints a meteorological summary. Subroutine ACESUM prints a summary of aircraft emissions. Subroutine ABESUM prints an airbase emission summary. Subroutine ENESUM prints a summary of environ emissions. Subroutine TOTSUM prints a total emissions summary.

The Source Inventory Program also now includes Subroutine PRTFLG, which prints bar graphs indicating pollutant concentrations. Subroutine MAJORT segments the sections of the printout between the major and minor titles. Subroutine OACSII prints aircraft source input information. Subroutine ODINFO prints engine emission factor default information. Subroutine OINCLC prints the results of engine fuel flow and emission factor calculations by aircraft mode. Subroutine TGLNIV defines touch-and-go line source geometry for a given aircraft.

The Short-Term Dispersion Program of OEHL had no subroutine changes from the current AFESC version. The OEHL version of AQAM also contains several smaller programs called AQEDT, SELIST, and EMGRAF. AQEDT is the input data edit routine designed to meet the machine-specific requirements of the OEHL computer system. SELIST is a program which extracts information from the Source Inventory Program and prints an emission inventory listing (an abbreviated source inventory listing). EMGRAF is a program which summarizes and displays AQAM output information in the form of histograms that are easy to read. Appendix A contains changes and errata needed to adapt existing literature for use with this modification.

2. Code Documentation

a. Complete Source Code Listings of the OEHL versions of the Source Inventory Program, and the Short-Term Dispersion, along with source code listings for AQEDT, SELIST, and EMGRAF are available at USAF OEHL, Brooks AFB, Texas. In addition, an excellent example of the OEHL Source Inventory Program input and output formats can be found in USAF OEHL Report 83-117EQ157CEB, <u>Pease Air Force Base Air Emission Inventory March 1983</u>.

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SECTION V

CHANGES AND ERRATA TO PRESENT AQAM DOCUMENTATION

Numerous changes in the AFESC version of AQAM were required to make the model operational on the OEHL computer. These changes became important to the user when inputting data using the Data Reduction and Operations Guide. Section A of Appendix A, documents the differences in the two versions of the model.

A major change in the model involved the addition of a Ground Support Equipment emissions subroutine to the OEHL version. The resulting changes to the Data Collection Guide are documented in Section B of Appendix A. Section C discusses the required changes to the subroutine, after an error was discovered in the original version.

Section D of Appendix A shows a comparative list of the original, current AFESC, and current OEHL subroutines of AQAM.

The user should ensure that these changes are annotated in the appropriate guide before data is input to the computer.

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SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

A. AIR QUALITY ASSESSMENT MODEL COMPONENTS

The technology transfer of certain portions of AQAM to the Occupational and Environmental Health Laboratory has been achieved. The present AQAM configuration at OEHL represents a basic capability in assessing the air quality of airbase installations and possesses certain enhanced output options not previously available. Other computer programs are in various stages of development and could further upgrade the OEHL configuration. Some examples are listed.

1. Source Inventory Input Interactive Modifier (SIIIM);
2. AICUZ-AQAM (AAI) Program (AICUZ stands for Air Installation Compatible Use Zone);
3. AQAM Long-Term Dispersion Program; and
4. Base Automotive Transportation Simulation (BATS) Model.

The following contain thoughts and recommendations concerning these programs and their installation at OEHL.

1. SIIIM Installation

The potential for completing and making the Source Inventory Input Interactive Modifier (SIIIM) operational is limited, with the existing program. The program required as input is a logically correct Source Input File, rendering SIIIM an adjunct to, but not a replacement for, either EDITR or AQEDT in the data preparation segment of AQAM. The data entry capabilities of EDITR and the data-checking capabilities of AQEDT are still required before SIIIM can be utilized. The program is also limited in scope. For example, it does not recognize Data Set 2 (NAMELIST Data) of the Source Input File and must be adapted to the new GSE subroutine (i.e., to Data Set 9). Furthermore, the sheer size of SIIIM makes installation on available computer systems impractical.

2. AAI Development and Installation

Analysis of the AICUZ-AQAM Interface (AAI) Program concluded that automating the flow of data from the AICUZ input file to the Source Input File of AQAM is difficult and of marginal value. However, some sort of interface between AICUZ and AQAM is justified, if only to coordinate the two types of airbase assessments. It is recommmended that an AAI Program, appearing as part of the data preparation segment of AQAM, be capable of presenting relevant data from an AICUZ input file to an AQAM user in the more familiar AQAM format. This reformatted data could then be used in creating a Source Input File.

3. Long-Term Dispersion Program

Installing the Long-Term Dispersion Program at OEHL involves, in principle, little more effort than that required to install the Short-Term Dispersion Program. A possible difficulty in this regard concerns reports of trouble in using the Long-Term Dispersion Program, which may be due to undocumented changes which have occurred. If it is decided to augment the OEHL capability with this program, it might be useful to validate and evaluate both dispersion programs to confirm whether or not they perform as advertised. At the same time, one could seek to remove the artificial restriction that a Source Input File contain at least one aircraft source, one airbase point source, etc.

4. BATS Installation

The installation of the Base Automotive Transportation Simulation (BATS) Model at OEHL would enhance to the data preparation segment of AQAM, in much the same manner as the AAI Program. Undocumented errors in the source, coding, and trimming of excessive computer core requirements should be addressed.

5. GSE Installation

This set of subroutines is embedded only in the OEHL version of the Source Inventory Program. This software displays GSE operations data, and retrieves and computes the GSE emissions for each aircraft type. With the exception of an error in the temperature-use factor, the GSE capability is fully functional on the OEHL version and could be installed for the AFESC version with reasonable effort.

B. ADVANCED TECHNOLOGY DEVELOPMENT

Advanced technology development should continue with a design emphasis on cost, simplicity of use, deliverability, and accuracy. Microcomputer software could be used, taking advantage of interactive modular logic and graphical input technology. By using inexpensive hardware and operating on minidisks, a wide access for various levels of engineers could be achieved. Operational simplicity is feasible, permitting easy storage, access, and updating with reduced training and experience requirements. The functions performed by the Air Quality Assessment Model could be made more efficient and effective with such advanced technology development.

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APPENDIX A

CHANGES AND ERRATA TO PRESENT AQAM DOCUMENTATION

This appendix presents changes and errata for existing AQAM documentation as listed in AFWL-TR-75-307, Air Quality Assessment Model (AQAM) Data Reduction and Operations Guide; Data Collection Guide, Draft Technical Report; correction to the GSE algorithm; and a list of subroutine changes.

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A. DATA REDUCTION AND OPERATIONS GUIDE

The following changes should be made to AFWL-TR-75-307, Air Quality Assessment Mode (AQAM) Data Reduction and Operations Guide.

1. Line and card changes:

Page	Disposition
31	Change CARD NUMBER 3, card columns 3-4, definition, line 2 to read:
	be identical to the runway identifier.
	Change CARD NUMBER 3, card columns 9-72, definition, line 2 to read:
	aircraft on this runway.* Columns 9-16
	Change CARD NUMBER 4, card columns 8-72 to read:
	9-72.
32	Change CARD NUMBER 5, card columns:
	2-4 to 1-4;
	6-8 to 5-8; and
	10-12 to 9-12
	Change CARD NUMBER 6, line 4 of footnote to read:
	Data set 5, Columns 9-16 contain...
33	Change CARD NUMBER 8, Line 4 of Footnote to read:
	Columns 9-16 contain.....
41	Change CARD NUMBER 1, card columns:
	4-32 to 9-72
60	Change CARD NUMBER 3, card column:
	20 to 36
62	Change line 2, card columns:
	41-45 to 41-48
79	Change CARD NUMBER 2, card columns:
	8 to 5-8
84	Change card columns:
	8-24 to 5-28
	Change lines, 5, 6, and 7 of definition to read:

Page	Disposition
	Columns 5-8, the second class is punched in columns 9-12, etc., to Column 28.
86	Change line 6 of definition to read: in Columns 9-12, etc., to Column 28.
91	Change CARD NUMBER 2, card columns 17-64, definition, line 5 to read: 17-24; the value...
92	Change card column 4-28 to 5-28 Change lines 5 and 6 of definition to read: 5-8; the second class is punched in Columns 9-12, etc., to Column 28.
100	Change card column 4-28 to 5-28 Change lines 5 and 6 of definition to read: Column 5-8; the second class is punched in Columns 9-12, etc., to Column 28.
169	Change DATA SET 9 description to read: Aircraft Ground Service Equipment
171	Delete variable IDRR from EGDATA NAMELIST
172	Delete variable TOWT and replace with RWROLL Acft ID -- Real km Runway roll
175	Change Aircraft name of Identification Number 29 to: Not Assigned. Change Aircraft name of Identification No.47 to F-16
191-193	Delete Table 22.

2. Page Changes

The following pages should be changed in the original document:

THIS PAGE REPLACES PAGES 17 AND 18, DATA SET 2, IN THE ORIGINAL DOCUMENT.

SOURCE INVENTORY DATA SET 2 - NAMELIST DATA (EGDATA, ACDATA, DSDATA, GSDATA)

The NAMELIST input consists of four NAMELIST group entries. Each group entry is named and allows the user to change internally programmed data values without permanently altering the computer code.

Each NAMELIST group entry, its associated variable names, and corresponding definitions are listed in Table 2. These values have been programmed into the AQAM code and, unless reassigned, they will be used in all calculations of aircraft emissions. If the user feels that his data are more accurate than those programmed, he may reassign these values by using the NAMELIST input data set (see appendix A). In this data set the user can change as many default values as necessary. However, even if no variable names are entered, each of the four NAMELIST groups must be included as part of the input data. In this case, each group would contain a null set of reassignments.

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THESE PAGES REPLACE PAGES 35 TO 40, DATA SET 9, IN THE ORIGINAL DOCUMENT.

SOURCE INVENTORY DATA SET 9 - GROUND SERVICE EQUIPMENT

Ground Service Equipment (GSE) consists of all motorized equipment except refueling tanks which are used to support incoming and outgoing aircraft. These support vehicles generally consist of coolers, power generators, heaters, and hydraulic test stands. The model assumes that all GSE activities occur in the aircraft parking areas, but the emissions are calculated separately from those emissions resulting from aircraft parking activity.

CARD NUMBER 1 FORMAT (I4,4X,5F8.3)

card columns	unit	definition
1-4	-	Number of ground service emission types (max. of 30, minimum of 1)
9-16	gal	Annual consumption of gasoline
17-24	gal	Annual consumption of JP-4
25-32	gal	Annual consumption of Diesel
33-40	gal	Annual consumption of JP-8
41-48	gal	Unassigned

CARD NUMBER 2 FORMAT (I4,F10.0,6X,8I1)

card columns	unit	definition
1-4	-	Ground service emission ID # (See Table 3A)
5-14	-	Fraction of use of ground service type
21-28	-	Usage indicator for each aircraft type defined in Data Set 4. Code a 1 if used, 0 if not used.

THIS CARD IS REPEATED FOR EVERY GROUND SERVICE EMISSION TYPE USED AT THIS AIRBASE AND THE NUMBER OF REPETITIONS MUST AGREE WITH THE TOTAL NUMBER OF GSE TYPES IN CARD 1, DATA SET 9.

THE FOLLOWING PAGE SHOULD BE ADDED IN TABLE 2 OF THE ORIGINAL DOCUMENT ON PAGE 173 BEFORE FOOTNOTES.

Variable	First dimension	Second dimension	Third Dimension	Type	Units	Definitions
GSNAME	GSE ID	-	-	Hollerith	-	GSE name (see Table 3A)
IGSCAT	GSE ID	-	-	Integer	-	GSE category (see Table 3A)
IGSFLT	GSE ID	-	-	Integer	-	GSE fuel (see Table 3A)
GSFF	GSE ID	-	-	Real	gal/hr	GSE fuel consumption rate
GSEMFC	Pollut ID	GSE ID	-	Real	kg/gal	GSE pollutant emission factor
GSRVCT	Acft ID	GSE ID	-	Real	hr	GSE service time by aircraft

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THESE PAGES, TABLE 3A, SHOULD BE ADDED AFTER PAGE 177 OF THE ORIGINAL DOCUMENT.

Table 3A

GSE NAMES, CATEGORIES, AND FUEL TYPES

GSE Identification No.	Name	Category	Fuel Type
1	H1	1	1
2	1H1	1	2
3	Not assigned	-	-
4	MA3	2	1
5	Not assigned	-	-
6	MD3	3	1
7	90G20P	3	2
8	AM32A60	3	2
9	Not assigned	-	-
10	MC1A	4	1
11	MC11	4	1
12	MC2A	4	1
13	1MC1A	4	2
14	MA1A	4	2
15	Not assigned	-	-
16	TTU228E	5	1
17	MJ1	5	1
18	MJ2A	5	1
19	1TTU228E	5	2

Table 3A (Continued)

GSE NAMES, CATEGORIES, AND FUEL TYPES

GSE Identification No.	Name	Category	Fuel Type
20	Not assigned	-	-
21	MJ1	6	1
22	MJ1A	6	1
23	MHU83AE	6	1
24	Not assigned	-	-
25	NF2	7	1
26	Not assigned	-	-
27	M32T1	8	1
28	Not assigned	-	-
29	M27M1	9	1
30	Not assigned	-	-
31	Not assigned	-	-
32	Not assigned	-	-
33	Not assigned	-	-
34	Not assigned	-	-
35	Not assigned	-	-
36	Not assigned	-	-
37	Not assigned	-	-
38	Not assigned	-	-
39	Not assigned	-	-

Table 3A (Continued)

GSE NAMES, CATEGORIES, AND FUEL TYPES

GSE Identification No.	Name	Category	Fuel Type
40	Not assigned	-	-
41	Not assigned	-	-
42	Not assigned	-	-
43	Not assigned	-	-
44	Not assigned	-	-
45	Not assigned	-	-
46	Not assigned	-	-
47	Not assigned	-	-
48	Not assigned	-	-
49	Not assigned	-	-
50	Not assigned	-	-

Table 3A (Continued)

GSE Category	Identification No.
Heater	1
Cooler	2
Generator	3
Compressor	4
Test Stand	5
Bomb Lift	6
Light Cart	7
Pressure Tester	8
Jacking Manifold	9
Not assigned	10
Not assigned	11
Not assigned	12
Not assigned	13
Not assigned	14
Not assigned	15

Table 3A (Continued)

GSE Fuel	Indentification No.
Automotive gasoline	1
Jet fuel (JP-4)	2
Diesel Fuel	3
Jet Fuel (JP-8)	4
Not assigned	5

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THIS PAGE, TABLE 5, SHOULD REPLACE TABLE 5 ON PAGE 178 OR THE ORIGINAL DOCUMENT.

Table 5

PLUME RISE FORMULA IDENTIFIERS

Formula Identification	Definition	Terrain Correction
0	None	No
1	Holland	No
2	Carson-Moses	No
3	Carson-Moses for training fires	No
4	Briggs	No
5	Holland	Yes
6	Carson-Moses	Yes
7	Briggs	Yes

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THESE PAGES, APPENDIX A, SHOULD REPLACE APPENDIX A ON PAGES 195-199 OF THE ORIGINAL DOCUMENT.

APPENDIX A

DEFINITION OF NAMELIST INPUT

Aircraft and temporal distribution data have been programmed as part of a data base in the AQAM source inventory computer code. These data include aircraft engine emission factors, aircraft landing and takeoff parameters, values for the temporal distribution of aircraft and airbase activity, and GSE parameters. All programmed data are listed at the end of this appendix. These programmed data are considered to be good overall averages and are automatically used by the program when the user has not input other data. If, however, the user has data he feels is more accurate for certain parameters than those programmed, he can, through the use of the namelist input, redefine these parameters in the code. Only the variables specifically stated in the namelist input will be altered and these alterations will not be permanently implemented in the code. Therefore, if these alterations are needed in subsequent runs, the namelist input cards containing these changes must be included in the source inventory input data deck.

All namelist variables and their defined meanings are listed in Table 2. The type of variable, along with the number and meaning of each dimension is also included. Each variable must be assigned constants in the "type" of the variable only. For example, if a namelist variable is defined as integer, only integer constants can be assigned to it. Variable types are explained in Appendix B. Many of the variables in the namelist are dimensioned, thus, they contain subscripts. A dimensioned variable allows many quantities to be represented with one variable name. A particular quantity is indicated by writing a subscript (or subscripts) in parentheses after the variable name. The individual quantities are called elements. A variable of one dimension contains a string of associated elements. The subscript indicates which element is to be considered. For example, TXISPD(3) = 15.4 indicates that the taxi speed of the B-57H aircraft is to be reassigned to 15.4. A two-dimensional variable is composed of horizontal rows and vertical columns. The first subscript refers to the column number. The total number of elements in the array equals the number of rows multiplied by the number of columns and again each element is indicated by a certain set of subscripts. For example, ACMO(2,3) = .4 indicates that the activity fraction for the B-57 aircraft in the month of February is to be reassigned 0.4. A three-dimensional variable is composed of three planes, each of which contain rows and columns intersecting each other at right angles. Once again, a particular element is indicated by the subscripts. For example, EGEMFC(1,2,4) = 23.4 indicates that the pollutant emission factor for carbon monoxide for the NORMAL mode of the TF33-P3 engine is to be reassigned to 23.4.

There is no outward display of the AQAM Source Inventory Code to indicate that namelist reassignments have been made. These changes are done internally by the code, but the user can verify that the proper elements have been reassigned by observing the programmed (default) data which are printed throughout the source inventory output. If namelist reassignments have been made, the replacement values will appear in the appropriate area of these printed default data.

Namelist reassignments are input in a free format. That is, the variable names and numbers are not punched in certain prescribed card columns; rather they are listed in a free form across the card with each variable and its assignment delineated by commas. Although the format is free, the rules for input of namelist information are explicit, and vary from one machine to another. Competent computer personnel should be consulted concerning these rules if the operator is uncertain of the form of namelist input for the computer being used. The rules set forth and the examples given in this manual are valid only for IBM series computers.

The namelist input in the source inventory consists of four namelist group names:

1. EGDATA
2. ACDATA
3. DSDATA
4. GSDATA

To reassign the variables associated with a group name, an ampersand (&) is punched in Column 2, followed by the group name and a blank. Variables are then input and when all necessary reassignments for this group have been made, another ampersand (&), followed immediately by "END", must be entered to terminate the reassignments. This terminator must follow the last assignment value. Card Columns 2 through 80 can be punched for namelist input. Card Column 1 is NEVER punched. Only variables associated with the group name can be defined and each variable name and its assigned value (including the last) is delimited by a comma. For example, if variables in namelist group name EGDATA were being defined, it is illegal to attempt to define RWROLL within this group since it is associated with namelist group name ACDATA. Additionally, within a given group name, only those variables to receive a new value are punched. For example, consider that group name EGDATA is being defined and the only reassignment involves changing the aircraft afterburner indicator for the F-100 aircraft from "on" to "off" and to reassign the identifier for the runway roll for the B-52H aircraft from 6000 to 6500 feet. These changes would be implemented as follows:

```
 &EGDATA IACABF(6) = O, RWROLL(2) = 6500, &END
|   |    |    |    |    |    |    |    |    |    |
1   5    10   15   20   25   30   35   40   45   50
```

CARD COLUMNS

If no changes are to occur, the card would be punched as follows:

```
&EGDATA   &END
|   |    |    |
1   5   10   15
```

CARD COLUMNS

If a sufficient number of changes occur, the assignments can be continued on several cards. However, a variable name with its assigned value and delimiting comma may not span from one card to another. If the user sees that a variable assignment will not fit between the last column punched and Column 80 of a card, these remaining columns may be left blank and variable assignments continued on another card starting in Column 2. Continuation cards <u>do not</u> contain the namelist group name and act merely as an extension of the first card. Consecutive cards can be added as necessary to complete assignments within a group. An "&END" indicating group name termination follows the last assignment on the last continuation card.

All namelist group names must be input for each source inventory run regardless of whether there are or are not reassignments. In addition, these groups must be input in the order listed in Table 2. A typical namelist data set structure may appear as follows:

```
&EGDATA   &END
&ACDATA   LNDSPD(19) = 396., &END
&DSDATA   ACMO(1,19) = .6, ACMO(2,19) = .6, &END
|   |    |    |    |    |    |    |    |    |    |
1   5   10   15   20   25   30   35   40   45   50
```

CARD COLUMNS

Certain namelist variables deserve special attention. They are ACNAME and EGNAME in group EGDATA, GSNAME in GSDATA, and APPHT and CLMBHT in ACDATA. Because of their Hollerith type, ACNAME, EGNAME, and GSNAME are unique among all other variables. These variables, when used, are assigned a string of alphanumeric characters to describe the aircraft and engine name. This string of variables must be defined in a Hollerith field. The Hollerith field consists of a number and an H, followed by the character string. The number defines the number of characters used to describe the aircraft or engine name (see Appendix B). A maximum of <u>eight</u> characters is allowed per string. For example, to reassign the name of Aircraft 5 from B-57E-G to B-57 and to reassign the name of Engine 1 from J79-G1 to J-79H, the following card would be punched:

```
&EGDATA  ACNAME(5) = 4HB-57, EGNAME(1) = 5HJ-79H, &END

1   5   10   15   20   25   30   35   40   45   50   55
                     CARD COLUMNS
```

Variables APPHLT and CLMBHT are not dimensioned. They are assigned a value without subscripts.

Although not essential, it is helpful if the user has a fundamental knowledge of FORTRAN and the AQAM code. If this is not possible, it is suggested that competent computer personnel be made available for consultation concerning the rules for creating a properly coded namelist data set.

The programmed values for every variable in each n[illegible]t group are listed in the following tables.

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B. DATA COLLECTION GUIDE, DRAFT TECHNICAL REPORT

The following pages in the Data Collection Guide, Draft Technical Report, should be replaced.

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THE FOLLOWING PAGES REPLACE PAGES 35-38 OF THE ORIGINAL DOCUMENTS

Ground Support Equipment:

Ground support equipment (GSE) includes all powered equipment used in the maintenance of aircraft, whether routine or nonroutine. Included in this category is equipment directly supporting aircraft systems such as ground power units, starter units, and hydraulic units, as well as equipment for indirect support such as lighting and towing units.

Information which must be supplied to AQAM concerning ground support equipment at an airbase falls into three categories:

1. An inventory of the types of GSE used at the airbase and the usage afforded each;

2. The types of GSE used to service each of the individual types of aircraft at the base;

3. The quantity of fuel consumed annually at the airbase by ground service activities. Given this information, which is quite airbase-specific, AQAM will allocate the total GSE fuel consumption to individual types of GSE servicing individual types of aircraft on a per-LTO basis. From this fuel allocation, pollutant emissions attributable to GSE can then be computed in a detailed manner.

The information listed above is best acquired from airbase personnel responsible for aircraft maintenance. Use of the worksheet shown in Figure 11 is recommended.

The leftmost column of the worksheet lists common types of GSE expected to be at an airbase. To create an inventory of GSE at an airbase, simply cross out those GSE types not used at the airbase and add to the list any additional types of GSE used at the airbase. The latter option should be exercised cautiously, as it involves a considerable amount of additional data collection and estimation and is unlikely to produce emission assessments which show any significant improvement in accuracy.

The second column of the worksheet specifies the usage accorded to each of the types of GSE in the airbase inventory. In general, usage figures will be based on a fraction of 1, where 1 is equal to 100 percent. The only case in which an alternative figure should be entered occurs when two types of GSE are used interchangeably (e.g., the H-1 and 1H-1 heaters). In this case, a valid usage figure can be obtained by equating the usage of a given type of GSE with its relative availability at the airbase. For example, if a base has 10 heaters, 3 H-1s and 7 1H-1s, it is reasonable to assume the usage of H-1s to be .300 (30 percent) and that of 1H-1s to be .700 (70 percent).

The remainder of the worksheet consists of eight columns which are labelled according to the types of aircraft at the airbase. The labelling should follow the order in which aircraft types are listed in the preceding tables. The data to be entered in each of these columns consist of check marks which signify whether a given type of GSE is used to service a given type of aircraft. For example, if a column were labelled KC-135A and if NF-2 light stands were used in servicing these aircraft, then a check would be entered at the intersection of the KC-135A column and the NF-2 row. Checks should be entered with care, because errors of omission are preferable to errors of commission. If a given type of GSE is rarely used to service a given type of aircraft, then the input should be disregarded. If a given type of GSE is rarely used to service <u>any</u> type of aircraft, then that type of GSE can be deleted from the AQAM airbase inventory.

The final set of data entered on the worksheet is the fuel consumption figures. In the space following each of the fuel names (Mogas, JP-4, diesel) at the bottom of the worksheet, one enters the amount of that fuel consumed annually by GSE. These figures are monitored carefully at airbases and should be readily available.

As a final check on the worksheet data, one should ascertain whether the servicing data entered in the table are consistent with the annual fuel consumption figures. It is not plausible,

GSE	USAGE	Aircraft								
HEATERS										
1. H1										
2. 1H1										
3.										
COOLERS										
4. MA3										
5.										
GENERATORS										
6. MD3										
7. 90G2OP										
8. AM32A60										
9.										
COMPRESSORS										
10. MC1A										
11. MC11										
12. MC2A										
13. 1MC1A										
14. MA1A										
15.										
TEST STANDS										
16. TTU228E										
17. MJ1										
18. MJ2A										
19. ITTU228E										
20.										
BOMB LIFTS										
21. MJ1										
22. MJ1A										
23. MHU83E										
24.										
LIGHT CART										
25. NF2										
26.										
PRESSURE TESTERS										
27. M32T1										
28.										
JACKING MANIFOLD										
29. M27M1										
30.										

MOGAS______ JP4________ DIESEL________

Figure 11. GSE Work Sheet

for example, that an airbase would show a significant consumption of Mogas and yet have no major Mogas-consuming type of GSE servicing an aircraft. More specifically, a large consumption of any given type of fuel is generally attributable to a generator which uses that type of fuel and services a type of aircraft with significant activity (i.e., a large number of LTOs annually). Therefore, a consistency check need only concentrate on generators, since these types of GSE are the major fuel consumers and thus the primary factors in total GSE fuel consumption.

C. CORRECTION TO GSE ALGORITHM

The GSE algorithm was incorporated within the Source Inventory Program mounted at OEHL. Since its mounting and publication of the supporting documentation, ESL-TR-81-60, Development of a Computer Emission Inventory Routine for Aircraft Ground Supoport Equipment, Volumes I and II, an error has been detected. The temperature-use factors as defined in Equations (6) and (7) (page 26 of Volume I) and applied in the source code (page 84 of Volume II) are in error.

Equation (6) should be replaced with:

$$\gamma_{heater} = \frac{[40 - \bar{T} + \Delta\bar{T}/2]^2}{2[\Delta\bar{T}/2]^2} \quad \text{unless if } 40 - \bar{T} + \Delta\bar{T}/2 \leq 0 \text{ then } \gamma = 0.$$

Equation (7) should be replaced with:

$$\gamma_{cooler} = \frac{[\bar{T} + \Delta\bar{T}/2 - 80]^2}{2[\Delta\bar{T}/2]^2} \quad \text{unless if } \bar{T} + \Delta\bar{T}/2 - 80 \leq 0 \text{ then } \gamma = 0.$$

To reflect these corrections, computer code listings between lines 200 and 210 should be changed as follows:

```
200       CONTINUE
          N1= THEAT-TBAR+DTBAR/2.0
          TMPFCT(1) = N1**2/(2.0*(DTBAR/2.0)**2)
          IF(N1.LE.0.) GOTO 201
          IF (TMPFCT(1). LE.O.) GOTO 201
          IF(TMPFCT(1).GE.1.) TMPFCT(1)=1.
          GOTO 202
201       TMPFCT(1)=0.
202       N2=TBAR+DTBAR/2.0-TCOOL
          TMPFCT(2)=N2**2/(2.0*(DTBAR/2.0)**2)
          IF(N2.LE.0) GOTO 203
          IF(TMPFCT(2).LE.0.) GOTO 203
          IF(TMPFCT(2).GE.1.) TMPFCT(2)=1.
          GOTO 204
203       TMPFCT(2)=0
204       DO 210 IC =3,15
          TMPFCT(IC)=1.
210       CONTINUE
```

Where THEAT=40

TCOOL=80

TBAR=$\overline{T}$

DTBAR= $\Delta\overline{T}$

D. LIST OF SUBROUTINE CHANGES:

ORIGINAL SUBROUTINES AS DOCUMENTED	CURRENT AFESC VERSION SUBROUTINES	CURRENT OEHL VERSION SUBROUTINES
	SOURCE INVENTORY PROGRAM	
ABARIV	ABARIV	ABARIV
ABLNIV	ABLNIV	ABLNIV
ABPTIV	ABPTIV	ABPTIV
ACEFCT	ACEFCT	ACEFCT
ACEMIV	ACEMIV	ACEMIV
ARRDEP	ARRDEP	ARRDEP
BLOCK DATA	BLOCK DATA	Deleted
CHARAC	CHARAC	Deleted
ENEMIV	ENEMIV	ENEMIV
EVAPHC	EVAPHC	EVAPHC
FIRST	Deleted	FIRST
INPUT	INPUT	INPUT
LAST	LAST	LAST
LETTER	LETTER	Deleted
MAIN	Deleted	Deleted
OABARS	OABARS	OABARS
OABLNS	OABLNS	OABLNS
OABPTS	OABPTS	OABPTS
OENEM	OENEM	OENEM
RRDIST	RRDIST	Deleted
TREFCT	TREFCT	TREFCT
TRNFLT	TRNFLT	TRNFLT
VEFCTR	VEFCTR	VEFCTR
VEHIC	VEHIC	VEHIC
	Add SRCINV	Add SRCINV
	Add CONVERT	Deleted
		Add ABEMIV
		Add ADLNIV
		Add AIRFLD
		Add GRDSRV
		Add GROUND
		Add GSEFCT
		Add METSUM
		Add ACESUM
		Add ABESUM
		Add ENESUM
		Add TOTSUM
		Add PRTFLG
		Add MAJORT
		Add OACSII
		Add ODINFO
		Add OINCLC
		Add TGLNIV

SHORT-TERM DISPERSION PROGRAM

ORIGINAL SUBROUTINES AS DOCUMENTED	CURRENT AFESC VERSION SUBROUTINES	CURRENT OEHL VERSION SUBROUTINES
ABABAR	ABABAR	ABABAR
ABLNAR	ABLNAR	ABLNAR
ABPTAR	ABPTAR	ABPTAR
ACSRCE	ACSRCE	ACSRCE
AINE	Delete	Delete
BLOCK DATA	BLOCK DATA	BLOCK DATA
CAVL	CAVL	Delete
CLASSE	CLASSE	CLASSE
DEPART	DEPART	DEPART
DIFERF	DIFERF	Delete
EMISAR	EMISAR	EMISAR
ENARAY	ENARAY	ENARAY
INDINP	INDINP	INDINP
MAIN	Delete	Delete
MAINS	Delete	MAINS
METHA	METHA	METHA
METHB	METHB	METHB
METHC	METHC	METHC
METHD	METHD	METHD
METHE	METHE	METHE
OUTPUT	Delete	Delete
PLRISE	PLRISE	Delete
POLSOR	POLSOR	POLSOR
PSEUDO	PSEUDO	Delete
QMOD	QMOD	Delete
READ	READ	READ
RISE	RISE	Delete
RRDIST	RRDIST	RRDIST
SIGY	SIGY	Delete
SIGZ	SIGZ	SIGZ
SOURCE	SOURCE	SOURCE
STPOL1	Delete	Delete
STPOL2	STPOL2	Delete
TRAN	TRAN	Delete
	Add ERF	Delete
	Add AQAMST	AQAMST
	Add OUTPUP	Delete
	Add INTRO	Delete
	Add LETTER	Delete
	Add CHARAC	Delete